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3. Oval or almond-shaped implements with a cutting edge all round, possibly used as sling-stones or as axes (fig. 1).

Mr. Evans points out, that in form and workmanship those of the two last classes differed essentially from the implements of the so-called Celtic period, which are usually more or less ground and polished, and cut at the wide and not the narrow end; and that had they been found under any circumstances, they must have been regarded as the work of some other race than the Celts, or known aboriginal tribes. He fully concurs with Mr. Prestwich, that the beds of drift in which they were found were entirely undisturbed.

X. "Observations on the Discovery in various Localities of the Remains of Human Art mixed with the Bones of Extinct Races of Animals." By CHARLES BABBAGE, Esq., M.A., F.R.S. &c. Received May 26, 1859.

Statements have recently been made relative to the discovery of works of human art occurring in a breccia amongst bones of ancient animals, hitherto supposed to have been extinct long anterior to the existence of our race. These observations are supposed by some to prove the great antiquity of the human race; whilst others, equally competent to form an opinion, admit that the intermixture of such remains presents a most perplexing mystery.

Whatever may be the result of yet unpublished or of future and more extensive observations, it is certainly premature to assign this great antiquity to our race, as long as the occurrence of such mixtures can be explained by known causes admitted to be still in action.

Two places have recently been pointed out in which such mixtures are stated to occur:—1st, certain localities in France; 2nd, certain caves in Sicily. The latter have been visited by Dr. Falconer, and as the information respecting them which we at present possess, though small, is yet much more definite than what is known of the French locality, my explanations will chiefly relate to the *latter*.

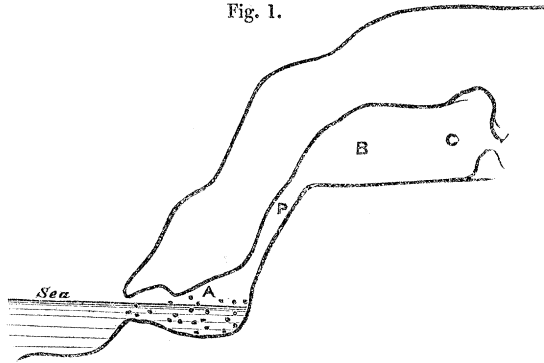
It is stated that one of the Sicilian caves has its sides perforated by marine animals.

That on penetrating the stalactitical incrustation covering the

roof of the cavern, and detaching fragments, it was found to consist of a breccia of bones of animals long extinct, mixed with fragments of flint or stone, bearing evident traces of human art.

In order to explain these circumstances, it is only necessary to admit the upheaval of the land and the occurrence of torrents.

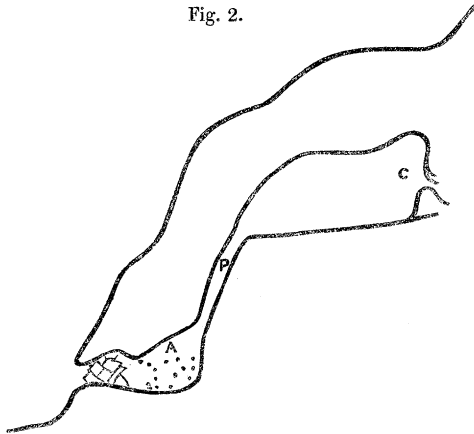
Fig. 1.



1st Period.—Let us suppose two caverns, a lower, A, and an upper, B C, communicating with each other by a long rent or pipe P. This pipe may be supposed of any height, sufficient when filled with water to produce the required force.

The lower cavern is supposed to be nearly at the level of the sea.

Fig. 2.



Pholades and other marine animals will perforate or attach themselves to the bottom and sides of the cavern, and if the sea entirely

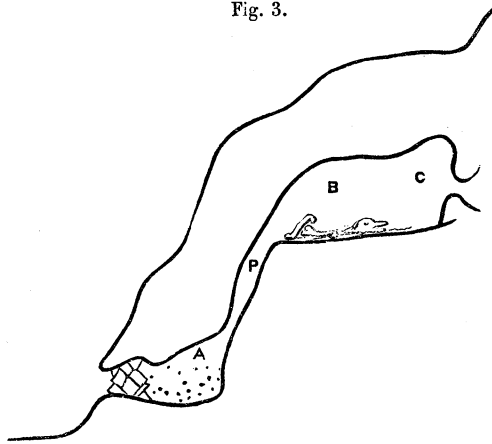
fill it : the roof, too, or at least that portion adjacent to the mouth of the cavern, may be similarly affected. The rocks in which these caverns occur may be of any geological age.

2nd Period.—By the gradual or quick upheaval of the strata in which these caverns occur, they may become dry.

During the rising, or at a later period, fragments of rock may have accumulated at the open mouth of the lower cavern, and thus have stopped up its entrance, leaving the roof, sides, and floors bearing evident traces of having been an ocean cave.

3rd Period.—Ages may have elapsed during which other strata may have been depositing in other portions of our globe. But ultimately the earth became inhabited by those ancient, but now extinct mammalia, whose remains abound in its caverns.

Fig. 3.

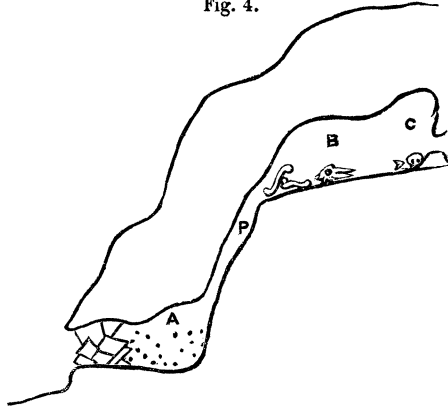


4th Period.—Ages may again have intervened when man, in his first rude state of existence, entering this deserted den through the opening its former occupants had used, might have been glad to shelter himself from an inclement climate in this bone-house of a more ancient world.

During this period traces of man's skill would probably be left within his miserable abode ; pottery, if he possessed the art ; charcoal or charred wood, if he were acquainted with fire ; rude cutting instruments of flint or other hard stone, perhaps spear or arrow-heads.

Fig. 4 represents the caverns at the end of the fourth period.

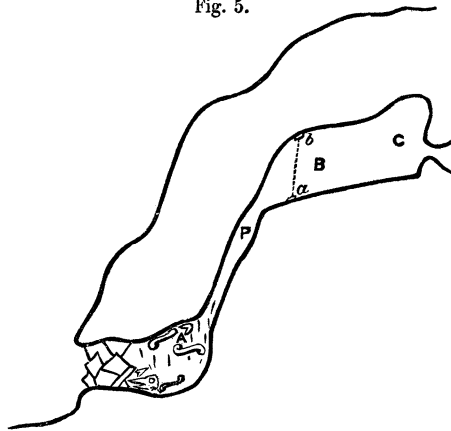
Fig. 4.



5th Period.—Torrents entering by the aperture at C, might now have swept through the upper cavern, perhaps at successive intervals of time. The effect of such torrents would be to wash from the sloping floor of the upper cavern, the mixed remains of animal and human life, together with the earliest traces of human art.

In some of these catastrophes, the workman, as well as his work, may have been entombed together in the lower cavern.

Fig. 5.



Thus in the course of time the whole of the lower cavern may have been filled up even to the roof.

This state is represented in fig. 5.

The effect of infiltration through the roof would now cement into a breccia the mingled remnants from the upper chamber, and enclose them, as it were, in a marble monument, in their new, though not their latest resting-place.

But the infiltration proceeding from the roof would act first, and most powerfully, in cementing the upper part of the intruded mass.

The lower portion would be less consolidated, and therefore less capable of resisting any pressure from above.

6th Period.—In the progress of time, some torrent of extraordinary magnitude may have penetrated through the upper cavern, and, filling the channel or pipe P, have acted by its hydrostatic pressure on the semi-consolidated matter in the lower one. As the water accumulated in the pipe, the pressure would become immense, and ultimately the materials included in the lower cavern would give way at their point of least resistance. This would probably be towards the middle or bottom of the original entrance. The first sudden rush would probably clear out the greater part of the contents of the lower cavern, leaving, however,—

1st. Those portions attached to the roof by the infiltrated matter.

2nd. Those portions on the floor more consolidated by pressure than the middle which gave way; and also other portions of the loose rubbish which the form of the floor at the entrance of the cave might have intercepted in its course.

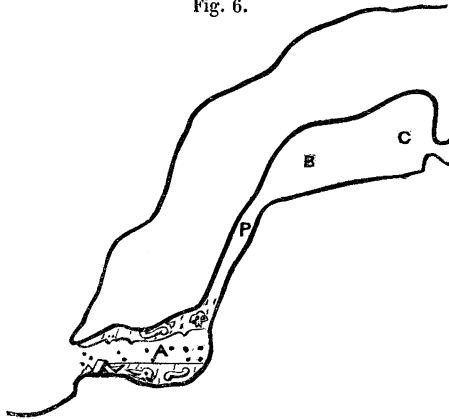
After this reopening of the lower cavern, the access of air would accelerate evaporation from its roof, and that portion of the breccia still adhering to it would gradually acquire the external coating of stalactite which usually occurs in caves.

In the meantime the dropping from the roof, falling upon the floor, might also contribute to consolidate the remaining fragments, and, although more slowly, cover the whole of them with a stalagmitic floor.

In this state, on entering the lower cave, the walls would be found perforated by marine animals, and no traces of animal life or of human art would present itself; but on excavating the floor, both would be found below the stalagmite; whilst if the curious inquirer should drive his pick into the roof, its fragments would bear testimony to the same fact.

Fig. 6 represents the final state of the cavern.

Fig. 6.



That caverns are occasionally filled with water, and after remaining full perhaps for centuries, are drained by artificial or natural causes, is well known. A very interesting case presented itself to me when visiting the caverns of Mitchelstown in Ireland.

These caverns had recently (1833) become accessible, and were then very imperfectly explored. I expressed to the guides my wish to visit some of the unexplored portion, and, after traversing various chambers during six hours, we entered a long and lofty cavern, the floor of which sloped rather steeply towards one side. The whole floor was covered with a coat of soft red mud, about three inches thick, still holding a portion of the water in which it had been suspended. No trace whatever of the footsteps of man or of animals appeared; the impression of our own feet alone marked the track up to the point which we had reached. Being rather in advance of my companions, my attention was suddenly attracted by what appeared to me to be about a bushel of soot lying in a small heap on the floor. On examination, I found it to consist of a moist spongy substance, of a black colour, which might, if dry, have assumed the form of a coarse black powder. Asking the opinion of my guide, he suggested that it might have been the remains of a fire lighted by some previous explorer; but this was inadmissible. I looked round for matter of the same kind, but on further search I could not detect any other instance; however, accidentally casting my eye

towards the roof of the cavern, I observed a black patch vertically above the heap of supposed soot lying on the floor, and from 20 to 30 feet above it. The dotted line, *a b*, fig. 5, may represent the position.

On my return from the cavern I examined the black sooty matter, and found that it left but very small traces under the action of the blowpipe.

On the following day, having made inquiries as to the drainage of the neighbouring country, I was informed that about twenty years before my visit, a stream of water had been diverted from the valley in which it originally flowed, into another adjacent valley.

I then visited several quarries, in one of which, about a mile from the caves, I observed a small stream of water terminating in a little pool or sink. In this pool I noticed slight eddies, which occasionally sucked in very small particles floating on the surface of the water.

I now visited the valley from which the original stream had been diverted, and found at some elevation a peat bog to which it had probably given rise. This peat was in several parts nearly black; the most decayed portion greatly resembled the black matter I had brought from the cavern. The origin of this black matter in the cavern now became apparent.

The large caverns I had visited were considerably below the level of the peat moss, and the stream which flowed through it. A portion of its waters was conveyed by sinks and crevices into the caves, and kept them continually full. There must, however, have been some very small leakage through which, when the stream which supplied the water was cut off, those caverns were, after many years, laid dry.

A small mass of unconsolidated peat, sufficiently light to float, must have been conveyed by the water into those caverns. When it arrived at the spot on which the black matter was found, the piece of peat which still floated must have been pressed against the roof of the cavern. Remaining there undisturbed for years, it may have become by decomposition specifically heavier than water, and then have subsided vertically down on the floor to the place on which I found it, leaving in the black spot on the roof the certificate of its former residence. On the other hand, the piece of peat may have retained its power of floating, and only have descended to the floor of the cavern by the slow escape of the water.

Such circumstances as these ought to induce us to examine with great caution, any instances of the occurrence of works of human art mixed with the remains of animals not yet proved to have been co-existent with man. Accident might have conveyed and hidden in the Mitchelstown caverns, a portion of human dress instead of a patch of peat. It is obvious that under slightly altered circumstances, instruments formed by man, the bony remains of his frame, or those of other recent animals, might, by still existing causes, be conveyed into deep recesses in the bowels of the earth, and there deposited with the remains of animals of an entirely different geological age.

Cases might occur in which the water passing in larger quantity would convey into such caverns a quantity of suspended mud, differing in its character at various seasons, and thus silt up the confused relics of distant ages in a regularly stratified deposit.

It is quite possible that the human remains might thus be enclosed beneath the stalagmitic crust, whilst the more ancient remains were scattered above it, uncovered, or covered by another coat of stalagmite.

If we suppose the existence of two upper caves, B and C, at different heights, each separately communicating with the lowest cave, A, as in fig. 7, then still more remarkable facts might ultimately present themselves to those whom accident should lead to examine the lowest cave. If, for example, the highest of these caves (C) contained only the remains of the extinct races of animals, and the other, or middle cave (B), nothing but those of man and the works of his own hands, the following series of events might occur :—

1st. A flood directing its course wholly through the middle cave (B), might wash down the fragments of the bones and works of man from that cave, and deposit them on the floor of the lowest cavern (A).

2nd. In a long series of years, a thick stalagmitic covering might be formed, giving an entire new stony floor to that cavern.

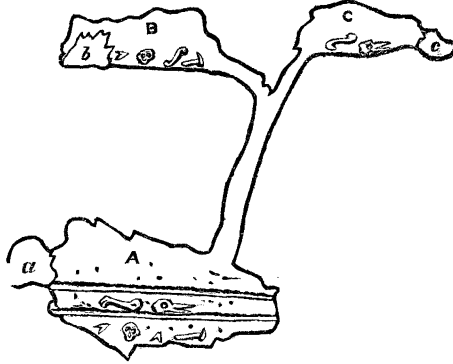
3rd. Afterwards another flood, rising to a higher level, accidentally taking its course through the highest cave (C), might cover this new stalagmitic floor of the lowest cave (A) with the bony fragments of these more ancient animals.

4th. The continued infiltration from above might again cover

these remains with another thick coating of stalagmite ; such alterations might even be several times repeated.

The annexed sketch will explain this case more clearly :—

Fig. 7.



The great geological law, that the order of succession of strata indicates the order of their antiquity, the lowest being always the oldest, is limited by the condition that those strata shall not have been removed from their original beds.

But the action of causes still existing may have produced apparent deviations from this order, and the present state of geological science seems to require an examination of such exceptional cases.

If a great river, similar to the Mississippi or the Amazon, flowed through a country whose superficial stratum consisted of a thin bed of chalk succeeded by gault, then during thousands of ages it would distribute, by means of an ocean current, its milky burden over the bottom of the existing ocean, on which, after a lengthened interval, a bed of chalk would reappear.

When the superficial bed of chalk over which the river flowed was cut through, its waters would begin to act on the newly-exposed gault ; and after another period of equally vast length, a stratum of gault might cover the chalk, thus producing an extensive inversion of the two strata.

But this would be dependent on the relative fineness and specific gravity of the particles of the two substances. It is *possible* that the particles of gault, if larger or of greater specific gravity than those of the chalk, might arrive at a greater terminal velocity, and

even overtake and pass through those of the chalk still suspended, thus forming a bed below the chalk, or a mixed bed of chalk passing into gault, and then ultimately a bed of gault above the chalk.

In such circumstances few or none of the larger fossils would occur, but possibly the remains of infusorial animals might enable us to identify the material of the ancient and of the new but inverted deposit of gault.

The case of remains of human art found imbedded with bones of extinct races of animals in deposits of ancient gravel, seems to require a different explanation.

Admitting, however, the existence of those animals to have been contemporaneous with the original distribution of the gravel, it by no means certainly follows that the race of man was coeval with them.

For the remains of man and his rude arts might occur on the surface of that gravel long ages after the extinction of those races of animals. Several causes might produce their mixture :—

1st. A vast lake bursting its barriers by erosion, or by an earthquake, might carry before it in its impetuous course the superficial remains of man, mixed up with vast quantities of gravel, containing the bones of the extinct races of animals, and deposit them over a large area of land at a lower level.

2nd. The change of the course of a river, or of a branch of its delta, might produce the same mixture of the remains of two distinct and far distant ages. It might, by the clearing out of its new channel, carry off the gravel and the remains of extinct animals, and deposit them, mixed up with specimens of human art, on spots which, after a few centuries, might again reappear as dry land.

3rd. A narrow pass, the outlet of a stream of water, might be stopped up by the avalanches falling from a glacier after a severe winter, and the lake formed by the stream might thus periodically rise, until the pressure broke through the barrier.

4th. Amongst the phenomena occurring during earthquakes, it has been observed that large cracks have suddenly opened and as suddenly closed, either immediately or shortly after. During these momentary or temporary openings, the remains of the arts of man, and even man himself, may have dropped into the chasm. Under such circumstances, remains of man and his arts might occur in

formations of any date. If the cleft occurred in rock or in any very hard material, traces of it would remain to indicate their origin. If it occurred in clay or softer material, the track through which these remains entered might be partially or even entirely obliterated. If the cleft occurred in tolerably compact gravel and then immediately closed, it would scarcely be possible at a future period to trace its origin.

The discussion of the recent observations of Mr. Prestwich on flints, worked apparently by the hand of man, found deeply imbedded in ancient gravel, as well as the extensive observations of Dr. Falconer on the bone-caves of Sicily, have given a new and important interest to the great question of the antiquity of the residence of our race on the planet we inhabit.

Having examined a few of these flint-instruments, I am satisfied that several of them have been worked by human hands. This opinion is founded upon the previous examination many years ago of the mode then used for making gun-flints.

Amongst the many valuable observations of Dr. Falconer, one fact to which he testifies deserves the most marked attention, and may possibly assist in directing us to the true solution of the problem.

Dr. Falconer has noticed the fact that the greater portion of these bones belong to the Hippopotamus, and also that they occur in their several deposits in enormous numbers. In each cave there must have been several thousands, if not tens of thousands, of individuals. The question immediately suggests itself, what causes produced this vast collection of individuals of the same race entombed in one common sepulchre?

It is scarcely possible to suppose that any instinct could have led the Hippopotamus, when death approached, to have chosen particular spots where the bones of his race were exposed to his view. If this were so, then most probably the existing race would possess the same instinct.

Another question arises : Were these remains originally deposited in different localities, and afterwards transported by some common cause to these various caverns and beaches ? Water seems the only probable mode of conveyance : if this were so, traces of the rolling action of water must be found on *all* the bones, but this I apprehend is not

the case. Moreover, it is difficult to conceive how water could have collected the bones of a multitude of individuals of the *same* race, distributed over a wide extent of country, into a few favoured localities. The bones of all other animals inhabiting the same country, and remaining on its surface, would have been exposed to the same action, and should have been deposited in the same tomb. If these animals all perished at the same time in each locality, some common cause must have produced the catastrophe.

Although the existing evidence may be insufficient to lead us to the true solution of this interesting question, yet it may be useful to throw out hypotheses, which, by accounting for some of the facts, shall direct the attention of future observers to the examination of such special points as may either partially support or directly disprove these conjectures.

With this view I shall offer two conjectures, one dependent on the subsidence of the land, the other upon the rising of the waters.

Conjecture I.—By the subsidence of the land.

Let us imagine that the basin of the bottom of the Mediterranean had at a former period been on a level with, or just above the African continent. Sicily and the various islands would then have stood above it as mountain chains.

One portion of the drainage of this land may have been effected by a vast river passing into the Atlantic through the opening now known as the Straits of Gibraltar.

In this state of things extensive freshwater lakes and other large rivers may have contributed to support large herds of Hippopotami.

In such circumstances the gradual subsidence of this land would check the outflow of its rivers, and occasion extensive marshes and lakes, a state of things favourable to the increase of the Hippopotami. As the subsidence proceeded, those animals which dwelt on the banks of the lakes and rivers would be driven inland. The waters of the Atlantic, entering through the channel of the former river, would convert the low ground and the marshes into sea, and thus gradually isolate the sinking land from the African coast.

When this state of the country had caused the Hippopotami to multiply rapidly, an increased rapidity in the sinking of its lands through the waters, might drive those animals rapidly to the higher

lands, which would then form islands, on the borders of which they would congregate in multitudes, until numbers of them, collected in ravines, rushing on in their attempts to escape in search of food, might trample each other to death and leave their bodies at the foot of impassable precipices washed by this new sea.

Conjecture II.—Let us suppose that the basin of the Mediterranean was formerly dry land shut in from the Atlantic by a barrier at the Straits of Gibraltar. In these circumstances the whole of the present Mediterranean Sea would have been a country sunk more or less under the level of the ocean; just as a large tract of country around the Dead Sea is at present.

The country included in this great depression might be warmer than others situated in the same latitude, and would be full of lakes fed by rivers, since there could be no drainage except from evaporation. It would therefore probably be favourable to the growth of the Hippopotamus.

Imagine now some convulsion to have opened the Straits of Gibraltar, so as to have allowed the waters of the Atlantic to enter this vast basin. The salt river thus introduced might require days, or weeks, or months, or years, before it filled this immense cavity; it might also increase its velocity as it wore away the channel of its entrance.

Under these circumstances the Hippopotami would be gradually driven to the higher ground, and those mountainous regions which now form the islands of the Mediterranean would then have received on their shores the hosts of animals, driven by this inundation to seek dry land on which to repose and food on which they might subsist.

Both of these hypotheses account for the aggregation in different localities, of the remains of large numbers of animals of the same class, dwelling amongst rivers and lakes; both equally account for their destruction on the same spots, either by trampling each other to death in the rush to escape, or by the slower processes of drowning or starvation. But neither hypothesis accounts for the fractured state of these bones, even though the animals should have rushed *over* the precipice. It might be expected that some portion of these Hippopotami, escaping from the deluge which destroyed their race, would have reached the plains of some larger island, and then

separating in search of food, have left their carcasses, wasted by famine, variously scattered at a distance from each other.

The following questions are thus suggested for inquiry :—

Are the bones of young and of old animals mixed indiscriminately throughout the whole of these bone-beds?

Is it possible to distinguish the bones of females from those of males?

Do the bones of the larger and stronger individuals occur in greater abundance near the top of the bone-beds, and those of the smaller and feebler animals nearer the bottom of those beds?

If the sea followed these animals quickly, the young and the feeblest would perish before they reached the great deposits of bones.

Although not at all confident that either of these explanations is the true one, I look upon them as open to less objection than any other of which I have yet heard, and therefore give them a temporary assent.

The conclusion to which these remarks lead, is that whilst we ought to be quite prepared to examine any evidence which tends to prove the great antiquity of our race, yet that if the facts adduced can be explained and accounted for by the operation of a few simple and natural causes, it is unphilosophical to infer the coexistence of man with those races of extinct animals.

The interest and importance of the subject are such, that new and still more extensive researches cannot fail to be made; and if these remarks shall in any way contribute to lighten the labour of future inquirers, or to promote the true explanation of the facts, they will have fully attained the object of their publication.

XI. "Remarks on Colour-Blindness." By Sir JOHN F. W. HERSCHEL, Bart., F.R.S.

[Extracted from a Report by Sir J. F. W. H. on Mr. Pole's paper on the same subject*, and communicated at the request of the President and Council.]

I consider this paper as in many respects an exceedingly valuable contribution to our knowledge of the curious subject of colour-blind-

* "Proceedings," vol. viii. p. 172; and vol. ix. p. 716.